NASA-CR-205690

International Ultraviolet Explorer
Final Archive
Contract NAS5-97042

Final Report

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Major Offices and Facilities Throughout the World

NAS5-97042 Final Report

Preface

This submission is the Final Report for the International Ultraviolet Explorer (IUE) Final Archive contract, NAS5-97042. The term of this contract is November 6, 1996, to October 9, 1997. The objective of this contract was the completion of GSFC activities associated with the processing and archiving of IUE Final Archive data. That objective was successfully met.

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1. Work Accomplished

a. Final Archive Processing

CSC processed IUE images through the Final Archive Data Processing System. Raw images were obtained from both NDADS and the IUEGTC optical disk platters for processing on the Alpha cluster, and from the IUEGTC optical disk platters for DECstation processing. Input parameters were obtained from the IUE database. Backup tapes of data to send to VILSPA were routinely made on the Alpha cluster.

IPC handled more than 263 requests for priority NEWSIPS processing during the contract. Staff members also answered various questions and requests for information and sent copies of IUE documents to requesters.

CSC implemented new processing capabilities into the NEWSIPS processing systems as they became available. In addition, steps were taken to improve efficiency and throughput whenever possible. The node TORTE was reconfigured as the I/O server for Alpha processing in May. The number of Alpha nodes used for the NEWSIPS processing queue was increased to a maximum of six in measured fashion in order to understand the dependence of throughput on the number of nodes and to be able to recognize when a point of diminishing returns was reached. With Project approval, generation of the VD FITS files was dropped in July. This action not only saved processing time but, even more significantly, also reduced the archive storage media requirements, and the time required to perform the archiving, drastically.

The throughput of images verified through CDIVS and processed through NEWSIPS for the contract period is summarized below. The number of images of a given dispersion type and camera that were processed in any given month reflects several factors, including the availability of the required NEWSIPS software system, the availability of the corresponding required calibrations (e.g., the LWR high-dispersion ripple correction and absolute calibration), and the occurrence of reprocessing efforts such as that conducted to incorporate the updated SWP sensitivity-degradation correction in May.

		NEWSIPS Processing					
		-------- Low Dispersion --------			-------- High Dispersion --------		
Month	**CDIVS**	**LWP**	**LWR**	**SWP**	**LWP**	**LWR**	**SWP**
November	485	60	0	119	0	0	3414
December	530	8	0	56	0	0	3325
January	270	144	0	229	0	0	3275
February	18	172	13	628	0	0	453
March	47	0	1786	0	0	0	15
April	19	90	2417	15	0	0	0
May	223	38	654	1389	0	0	2480
June	284	0	2830	0	880	0	5
July	26	66	2194	617	4813	0	28
August	284	291	801	1865	1879	4153	323
September	310	432	710	1091	393	350	139
October	67	53	37	83	81	79	100
Total	2563	1354	11442	6092	8046	4582	13557

A total of 487 tapes of NEWSIPS data, processed on the Alpha cluster and the DECstations, was shipped to VILSPA during the contract period. An accounting of the BOLS sent to the NSSDC as well as the tapes shipped to VILSPA is contained in the table below.

Month	**BOLs (Alpha)**	**BOLs (DEC)**	**VILSPA Tapes**
November	23	3	65
December	23	3	10
January	22	3	20
February	5	11	93
March	1	19	40
April	0	27	35
May	10	24	0
June	6	32	54
July	24	32	46
August	24	26	80
September	8	29	0
October	6	4	44
Total	152	213	487

b. Calibration

During the contract period, CSC completed the derivation and/or evaluation of a number of important calibrations for NEWSIPS. These include the following:

- LWR trailed-to-large aperture and large-to-small aperture low-dispersion absolute calibration correction ratios for ITF B
- LWR sensitivity degradation correction for ITF B
- LWR, SWP, and LWP large- and small-aperture areas
- LWR NEWSIPS high-dispersion spatial and spectral resolutions
- LWR low-dispersion absolute calibrations for ITFs A and B (evaluated the calibration derived by VILSPA)
- LWP high-dispersion ripple correction and absolute calibration (evaluated the calibration derived by VILSPA)
- LWR high-dispersion ripple correction and absolute calibration (evaluated the calibration derived by VILSPA)

The calibrations derived by CSC were all documented in the *IUE NASA Newsletter* and *NEWSIPS Information Manual, Version 2.0*. In addition, the NEWSIPS manual itself, representing a major update of Version 1 to include LWR low-dispersion and SWP, LWP, and LWR high-dispersion algorithms and calibrations, was completed. It has been submitted for publication as a special issue of the *IUE NASA Newsletter* and is to be made accessible in electronic form on the World Wide Web.

CSC performed a number of investigations and analyses to resolve questions about NEWSIPS algorithms or calibrations that arose during the contract period. The questions, issues, and investigations are summarized below.

- Undesirable spectral signatures were imposed by the low-dispersion absolute calibrations derived by VILSPA, especially for the LWP camera. Analysis indicated this is apparently related to intrinsic residual detector non-linearities and the piecewise combination of 100-percent and 200-percent-level exposures of standard stars to derive the inverse sensitivity function. VILSPA indicated they would look into possibilities for remedying this situation.
- Inaccuracies were detected in the extrapolation of the low-dispersion sensitivity-degradation correction for SWP data for post-1995 observation dates. CSC analyzed the most recent standard-star and white-dwarf observations available (1995 and 1996) to update the SWP point-source sensitivity-degradation correction. CSC also determined that the existing SWP trailed-source and LWP point-source and trailed-source sensitivity-degradation corrections were valid and did not require updates. The LWR sensitivity-degradation correction was never in question inasmuch as the LWR correction was derived from the closed dataset of LWR observations and did not involve any time extrapolation.
- LWP high-dispersion order-registration anomalies were seen in the data set of images processed for derivation of the LWP ripple correction. The combination of detector

sensitivity and source spectral energy distributions caused problems for certain classes of LWP spectra. New checks for properly-bounded registration solutions were added to the NEWSIPS algorithms for the LW cameras to protect against potential "runaway" solutions by reverting to global or time/temperature-predicted registration shifts in such cases.

- Apparent flux deficiencies in specific high-dispersion orders as extracted by NEWSIPS (three orders for the LWP camera, one order for the LWR camera) were seen in the ripple-correction data sets for the LW cameras. This was traced to an extraction-centroiding problem caused by an obscure numerical instability involving the interplay among the precise starting location of the centroiding window, the search-window size, and the extraction slit length. The problem was eliminated simply by adding a small (subpixel) perturbation to the starting search location. It was also verified that SWP spectra are not affected.
- Analysis conducted by CSC determined there are no clear benefits in terms of photometric noise, reliability of background fluxes, or improvements in the wavelength scale, associated with the use of ITF B for LWR high-dispersion images. As a result, NEWSIPS high-dispersion processing for LWR data uses only LWR ITF A. This is in contrast to LWR low-dispersion, where clear-cut improvements result from the ability to choose between ITF A or ITF B on an image-by-image basis.
- Apparent ripple-splicing and background-level anomalies were reported in certain SWP high-dispersion spectra of B stars by a user. CSC determined that the NEWSIPS background-determination module was performing according to design and that the observed behavior of the background as modeled by NEWSIPS reflects a limitation in the ability of an automated process to respond to localized background variation or the effects of peculiar pathologies in individual images. A detailed description of the background determination algorithm was written and made available to users in advance of the publication of the *NEWSIPS Information Manual, Version 2.0*, via the World Wide Web.
- Anomalously low sigma values in some LWR low-dispersion images resulting in higher-than-normal fluxes as extracted by the SWET module were reported by a user. CSC determined the cause of this behavior to be the improper extrapolation of the low-dispersion noise model polynomial fits at large FN values. This issue was resolved by setting the noise value at large FNs to the peak of the polynomial curve representing noise as a function of FN rather than allowing it to follow the turnover of the fitted curve. The affected data were reprocessed and re-archived. The SWP and LWP low-dispersion noise models were then also examined and found to exhibit this same extrapolation behavior, but to a much, much smaller degree since the turnover of the fitted functions for those cameras occurs at considerably higher FN levels than for LWR, and only at the shortest wavelengths. No remedial action was required for SWP and LWP.
- CSC determined that the LWR noise-model anomaly did not affect in any significant way the derivation of the LWR low-dispersion absolute calibrations for either ITF A or ITF B. Furthermore, it demonstrated that high-dispersion data, in any camera, are not subject to this sort of noise-model anomaly, since in high-dispersion the noise models are handled differently, intrinsically limiting the noise values at high (and low) FNs. In addition, the noise values in high dispersion are not used by the boxcar extraction method as SWET does for low dispersion and thus cannot affect the extracted fluxes.

- CSC verified the validity of the technique used to establish the IUE wavelength calibration for large-aperture spectra in high dispersion. In NEWSIPS, as in IUESIPS, the large-aperture wavelength calibration is obtained from the small-aperture calibration by a simple zero-point shift corresponding to the physical offset between the apertures. Echelle grating theory as applied to the IUE instrument design led the calibration staff to question whether a small wavelength-dependent dispersion differential might be detectable between small-aperture high-dispersion data and large-aperture high-dispersion data calibrated in the standard fashion. Tests performed by the staff on both IUESIPS and NEWSIPS data sets, however, showed that small- vs. large-aperture wavelength differences, obtained by cross-correlating small- and large-aperture extracted spectra of the same target, exhibited only random offsets that could not be distinguished from target-centering errors in the large aperture. We therefore concluded that the IUE large-aperture wavelength calibration methodology is adequate as implemented.
- In support of VILSPA's compatibility testing of the NEWSIPS high-dispersion Ultrix system against the corresponding Open VMS version, and to better understand the quantitative differences between the results obtained on the two systems, the calibration and software staffs worked together to conduct a series of tests using the images SWP2860 and SWP5136. Investigations made last fall indicated that differences in the final net fluxes obtained with the two systems were ultimately traceable to minute irreducible differences (hundredths or thousandths of a pixel) in the displacements in the ORD.MSK and VD.MSK files, caused by differences in machine architecture and calculational precision. The new tests reconfirmed this result and demonstrated that the Ultrix software is functioning correctly. Final Ultrix fluxes in high dispersion can vary from the OpenVMS fluxes by amounts depending on the flux levels, with the largest percentage differences in cases where the background level is very low and/or where there is essentially no gross flux.
- An error in the way the sensitivity-degradation correction was applied for LWP and LWR high-dispersion data with NEWSIPS 3.3.1 and 3.3.2 was uncovered by the IUEDAC. Analysis showed that a hardcoded parameter value pertinent to the SWP camera was inadvertently being used for both LW cameras, causing the wrong degradation correction to be applied for wavelengths above 2712 Angstroms. An IDL-based correction procedure was developed, tested, and implemented to allow the re-archiving of corrected MXHI files for the affected LW images.
- The calibration staff evaluated the quality of the LWR ripple correction and absolute calibration derived by VILSPA. In brief, all of the images evaluated show overcorrections in the wings of the ripple-corrected orders at short wavelengths (typically below ~2300 Angstroms). The severity of the overcorrections is greatest for images obtained during early epochs, with bad focus, and through the small aperture. In general, in these same images the overcorrection persists to longer wavelengths than in images that are less severely overcorrected. The general property of overcorrection at short wavelengths was previously also found for LWP images, although not as extremely so. The overall quality of the NEWSIPS ripple corrections appears poorer at short wavelengths, comparable at intermediate wavelengths, and better at long wavelengths as compared to the IUESIPS results, which tend to show mediocre ripple corrections at all wavelengths, and in general, an undercorrection. In August, VILSPA declared the LWR ripple correction unacceptable and is currently exploring

means of improving it and re-archiving the GSFC data processed using their original (unacceptable) ripple correction.

The software group developed, tested and delivered a number of NEWSIPS software releases to VILSPA and to the IPC during the contract year. The table below lists these deliveries in chronological order and summarizes their content.

Release	Platform	Description
2.5.1	Ultrix	3-camera low-dispersion system, with ITF selector for LWR; no LWR absolute calibration for ITF B.
3.1	Ultrix	SWP high-dispersion system
3.1_A	OpenVMS	SWP high-dispersion system
3.2	Ultrix	SWP/LWP high-dispersion system, but with no LWP ripple and absolute calibration
3.2_A	OpenVMS	SWP/LWP high-dispersion system, but with no LWP ripple and absolute calibration
2.5.2	Ultrix	3-camera low-dispersion system complete with all calibrations
2.5.3	Ultrix	Adds updated SWP point-source sensitivity-degradation correction and correction for LWR low-dispersion noise-model anomaly to 2.5.2.
3.3_A	OpenVMS	3-camera high-dispersion system, but with no LWP or LWR ripple correction and absolute calibration.
3.1.1_A	OpenVMS	Adds updated SWP point-source sensitivity-degradation correction to 3.1_A
2.5.4	Ultrix	Adds DMU anomaly handling to 2.5.3
3.3.1_A	OpenVMS	Adds LWP ripple correction and absolute calibration, DMU anomaly handling, and updated SWP point-source sensitivity-degradation correction to 3.3_A
3.3.2_A	OpenVMS	Adds LWR ripple correction and absolute calibration, VD-file suppression, and several other minor changes to 3.3.1_A.
3.3.1	Ultrix	Adds LWP ripple correction and absolute calibration, DMU anomaly handling, and updated SWP point-source sensitivity-degradation correction to 3.3.
3.3.2	Ultrix	Adds LWR ripple correction and absolute calibration, VD-file suppression, and several other minor changes to 3.3.1
3.3.3	Ultrix	Adds corrected application of LWR/LWP sensitivity-degradation correction and several other minor changes to 3.3.2
3.3.3_A	OpenVMS	Adds corrected application of LWR/LWP sensitivity-degradation correction and several other minor changes to 3.3.2_A.
2.5.4_A	OpenVMS	Port of 2.5.4 (final 3-camera low-dispersion system) to OpenVMS

CSC also completed and delivered a major document, *International Ultraviolet Explorer New Spectral Image Processing System (NEWSIPS Pipeline) Low and High Dispersion Functional Specifications and Detailed System Design*. This document contains the information needed by users to build and execute the NEWSIPS software in either the Ultrix or OpenVMS environments.

c. Data Archiving Support

IUE archive support services were provided using the NDADS systems. In all, during the contract period 350 electronic data deliveries, encompassing 216,638 files for 45,160 images, were received from the GSFC Final Archive Processing systems. All of those deliveries will have been archived onto optical disk platter by the end of the contract period. In addition, 99 tapes of NEWSIPS data from VILSPA were received. The most recent delivery of VILSPA tapes was not received in sufficient time to be completed before the end of the contract period. Seven of the tapes have been archived. The remainder will be archived to optical disk platter on a new contract.

Numerous problems with the NDADS hardware system were experienced. These problems include parity errors and the media going off-line during platter writes as well as frequent downtme for jukebox maintenance and inventories.

Task members initiated an inventory of master tapes containing IUESIPS data. All 538 "C" copies of the VIL tapes (IUESIPS data from VILSPA) have been inventoried. Of the 538 tapes, 70 (13 percent) had some type of problem.

Eight hundred seventy-three "C" copies of 1,447 "NAS" tapes have been inventoried. Work to inventory the remaining "C" copies and to read the "D" copies for the unreadable tapes will continue on a new contract.

CSC developed plans for copying the IUE Final Archive data to DLT media. In all, 16 tapes were completed. Copies of 5 of the tapes have been made for PPARC. In addition, work began on an effort to put IUESIPS data onto DLT, beginning with the raw-image files.

During August it was discovered that a good portion of the data written to platter between June 8 and July 27, 1997, was corrupted during the write-to-platter process. Although the exact reason has not been determined, the cause of the problem involved a subtle NDADS system failure beyond CSC's control. A clean copy of the Final Archive data for all but 400 images was preserved on DLT tape, and this was used to rewrite the data to platter. The 400 images not recoverable from DLT were reprocessed and re-archived.

The Archive Support group coordinated efforts with the IUEDAC and calibration staffs to develop, test, and implement an IDL-based procedure for correcting archived LWR and LWP MXHI files affected by the NEWSIPS 3.3.1 and 3.3.2 error in applying the sensitivity-degradation

correction for wavelengths longer than about 2712 Angstroms. The procedure was run directly on the NDADS system and was used to re-archive correct copies of the data.

d. IUE Data Analysis Center (IUEDAC) Operation

During the contract period, special assistance was provided to users and remote user accounts were maintained as outlined in the table below.

Month	Users Given Special Assistance	Remote User Accounts Maintained
November	12	32
December	9	32
January	15	24
February	16	26
March	14	32
April	11	26
May	19	28
June	13	31
July	13	34
August	12	27
September	18	38
October	4	38

During the contract period the IUE electronic newsletter was distributed monthly, and routine backups and system maintenance were performed for nodes IUEWWW, KLUGE, VACUUM, and VOID. In all, 16 routines were added to the experimental library and 57 were implemented. Six new calibration files were implemented. Software registration forms were received from 17 new remote sites and 3 requests for the IUEDAC software were received. The IUEDAC software registration form itself was updated, the Copernicus catalog was updated, the description of the Final Archive status flags was updated, and the IUEDAC Users' Guide was updated. The IUEDAC software was updated to support high-dispersion Final Archive data, as resources allowed. The IUE Merged Log was updated three times.

e. Computer Systems Operation and Maintenance

As appropriate, systems personnel redistributed computer equipment to maximize overall productivity and coordinated identification of unused equipment to be excessed. Routine system maintenance and troubleshooting efforts continued.

In early spring, systems management staff coordinated the efforts of the IPC staff, the software staff, and LASP personnel to establish a test environment at GreenTec for assessing the impact on MIDAS of the LASP's upgrading its Alphas to the VMS 7.1 system. This testing was imperative to avoid potential disruption of the Alpha pipeline processing environment at LASP. After

running preliminary tests and establishing a comprehensive upgrade plan, the systems management staff accomplished the system upgrades needed to establish a test environment for OpenVMS 7.1. Operating system and compiler components were installed on a test platform (NEBULA) to mirror the expected configuration of the LASP Cluster, as follows: OpenVMS Operating System V7.1, DECnet for OpenVMS Alpha V7.1, DECwindows Motif V1.2-4, Digital FORTRAN V7.1, DEC C V5.5, and Multinet V4.0. This environment allowed the software staff to successfully test NEWSIPS and MIDAS under the upgraded operating system, thereby verifying that the upgrade would not disrupt NEWSIPS pipeline operations.

In March, systems personnel responded to significant security concerns that had been raised by a break-in on the GSFC web site. Upgrades and new installations of security measures were begun. In response to security briefings by the GSFC CNE, system management staff put in place new incident reporting procedures, and security upgrades and patches to the Unix systems were installed.

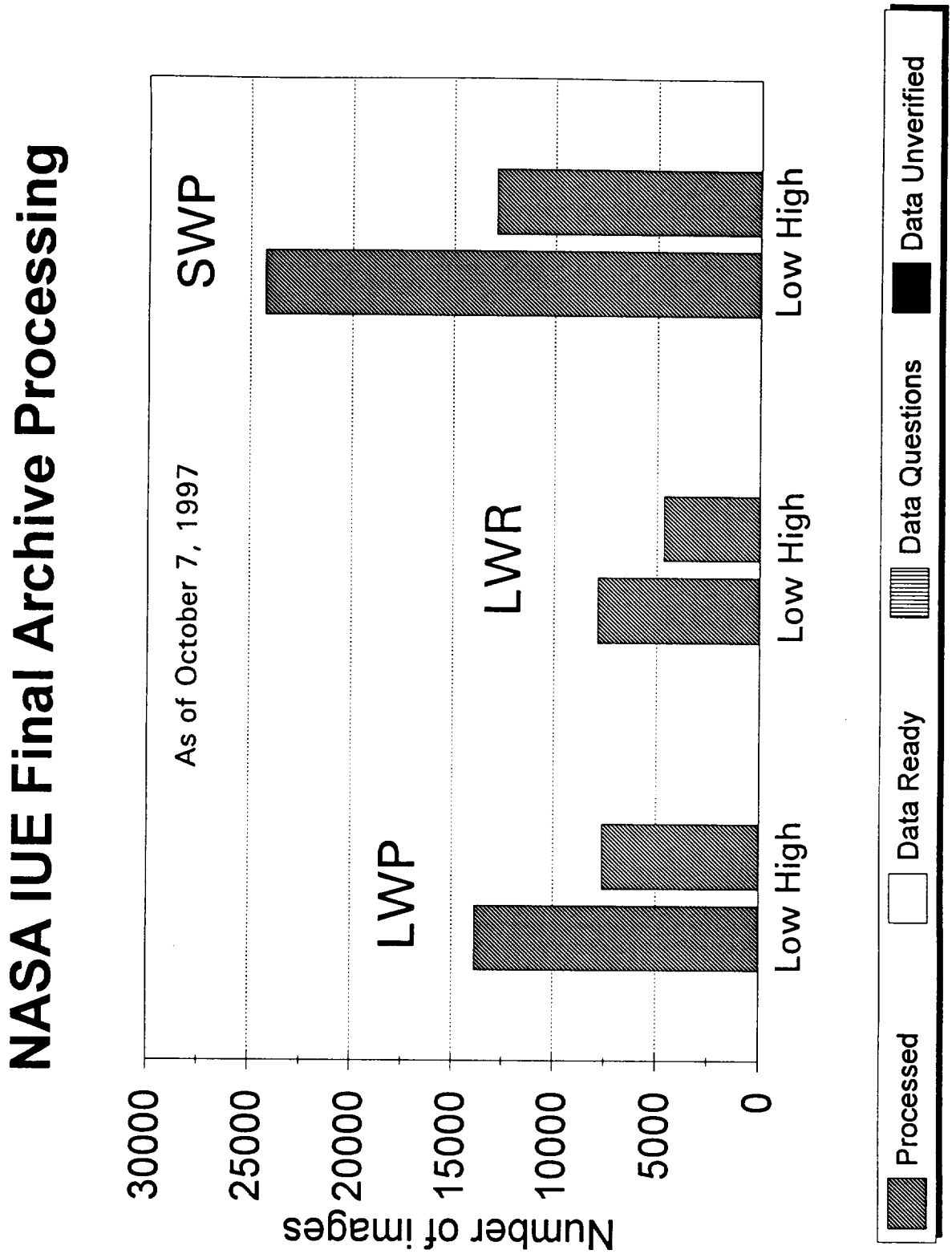
The systems staff worked with NSI to upgrade to the new Cicso router installed at GreenTec in April; users reported an immediate improvement in network performance as a result of this upgrade.

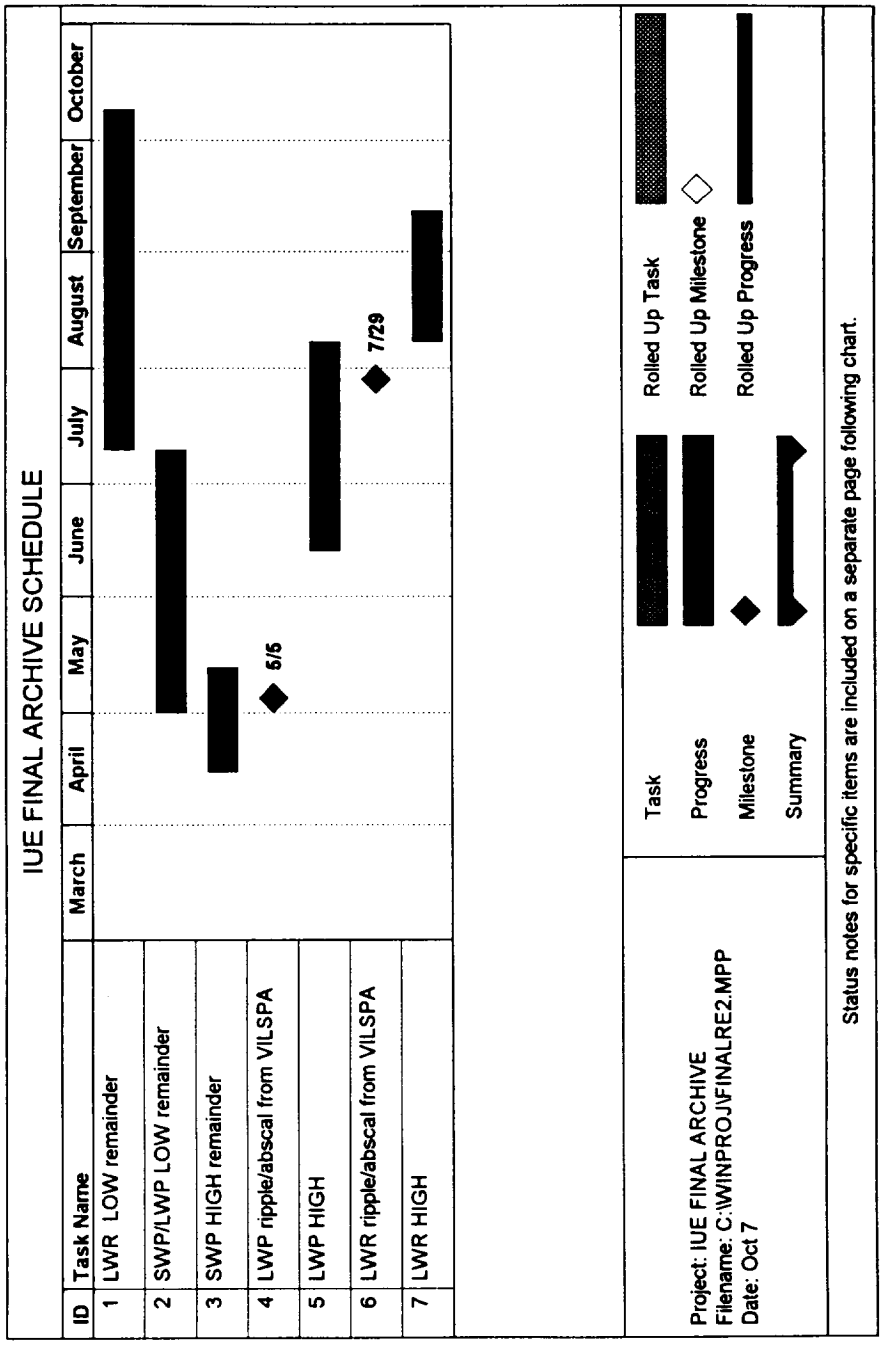
Additionally, systems personnel coordinated efforts with CSC project management to conduct a detailed inventory and create an annotated tabulation of all Government-Furnished computing equipment at the GreenTec site to facilitate contract close-out activities.

f. Management and Administration

On a weekly basis CSC project management collected quantitative measurements of progress in Final Archive development and processing activities and displayed the data for project and NASA use. A processing-statistics histogram was provided on monthly basis and a Gantt chart depicting progress on development and processing activities was provided weekly. The contents of the Gantt chart were modified as appropriate during the contract period to reflect the tracking of those activities that were most significant at the time of reporting. The final histogram and Gantt chart are shown on the following pages. All processible IUE images, with the exception of an agreed-upon small group of engineering and test images of no scientific value, were archived. Among the unprocessible images, the vast majority have problems with the raw image which prevent successful processing.

CSC project management coordinated the attendance and reporting by technical staff at weekly IUE Final Archive project meetings with the NASA COTR. CSC management continued close interaction with project technical staff on a daily basis to supervise activities, assess the adherence to work plans and standards and the achievement of objectives and milestones, set priorities, maintain and balance resources, and identify and address any potential or actual problems.


NASA IUE Final Archive Processing
As of October 7, 1997
Number of images
30000
25000
20000
15000
10000
5000
0
LWP
LWR
SWP
Low High
Low High
Low High
Processed
Data Ready
Data Questions
Data Unverified


IUE FINAL ARCHIVE SCHEDULE
ID
Task Name
March
April
May
June
July
August
September
October
1 LWR LOW remainder
2 SWP/LWP LOW remainder
3 SWP HIGH remainder
4 LWP ripple/abscal from VILSPA
5 LWP HIGH
6 LWR ripple/abscal from VILSPA
7 LWR HIGH
5/5
7/29
Project: IUE FINAL ARCHIVE
Filename: C:\WINPROJ\FINALRE2.MPP
Date: Oct 7
Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress
Status notes for specific items are included on a separate page following chart.

CSC project management coordinated with the COTR to define those records, documents, and other materials pertaining to the IUE mission which could be disposed of and/or recycled, and those which should be retained. A complete set of IUE NASA Newsletters, IUE Three-Agency Coordination Meeting Records, and IUE Users' Committee Meeting Records has been preserved, along with a copy of unique technical documents such as IUE System Design reports, camera manuals, and other instrument or operational specifications that may of long-term value beyond the end of the project. These materials are expected to be turned over to the group continuing IUE archive support at the Space Telescope Science Institute (STScI) after the end of this contract.

CSC project management coordinated the categorization of all Government-Furnished Equipment at the GreenTec facility assigned to this contract in order to facilitate the efficient and cost-effective disposition of that equipment at the close of the contract. This effort included the identification of potential users (i.e., other government contracts) of equipment not earmarked for return to the LASP or to be used by the IUE archive group at the STScI. CSC project management coordinated these issues with the LASP, the STScI, and the CSC Property Management Office (PMO).

CSC project management completed its active efforts on personnel placement issues. Particular care was taken to ensure smooth completion of work within the budgetary framework of the contract as new assignments were arranged for project personnel after the end of the contract.

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13. ABSTRACT *(Maximum 200 words)*

This report is the November 6, 1996 - October 9, 1997 IUE Final Report for the International Ultraviolet Explorer (IUE) Final Archive contract. The ultimate objective of this contract is the completion of the archival reprocessing of all IUE data obtained at GSFC between 1978 and 1995.

14. SUBJECT TERMS

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